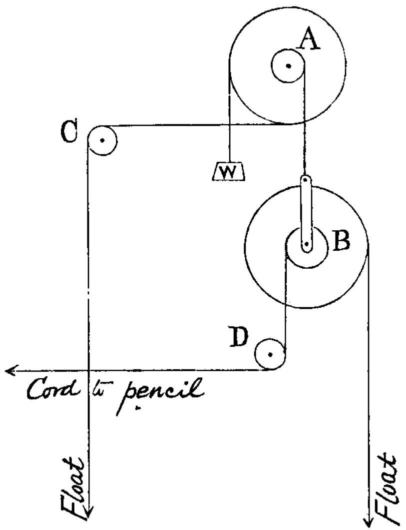
昇レリ實ニ中越之實庫トシテ商賣并ニ金力ノ中心ヲ占ムルモノト云フモ敢テ不可ナキノミナラズ尚進ンデ一面ハ高岡市ヨリ伏木港ニ出テ氷見町ニ延長シ一面ハ福野町ヨリ井波町ニ支線ヲ設ケ以テ一大市場ヲ圍繞シ運輸交通ノ便ヲ開クノ計畫アリ前途益多望ナリ本鐵道工費ハ參拾五萬圓ニシテ延長拾八哩五拾鎖ヲ有シ鐵軌ハ參拾磅ヲ用ヒ軌間ハ三呎六吋滊鑵車ハウヲキンクヲルダーニテ拾八噸トセリ地勢ハ北ヨリ南ニ向ツテ進ミ全線平坦砥ノ如ク只タ終局ノ停車場タル城端福光町間ニ八十分一ヲ五拾鎖存スルノミ橋梁ハ拾五呎以上總テプレートガーダーニテ山田川ヲ以テ最大トス(五十呎四桁)其外四十呎以下ノモノ貳拾六ケ所アリテ地層ハ多ク砂利層ニテ到ルトコロ尺土ヲ堀起サバ悉ク砂利ナラザルハナシ地盤最モ堅牢ニシテ杭打工ヲ要スルノ箇所ヲ見ズ土工ハ築堤切取共平均高四尺內外ナリ前陳ノ如ク工事ノ平易ナル多ク其ノ比ヲ見ザルカ如シ尚ホ功程ノ進ムニ從ヒ細報スル處アラントス聊カ大要ヲ記シテ他日ヲ待ツ

The Discharge Recorder as used in the Osaka Water Works Reservoir

By T Sano, Engineer to The O. W. W.

It would be by no means *unimportant* in the management of any water works to have some arrangement whereby the continuous record of the water consumption can be obtained. The simplest method would be to construct an overflow weir of a known length at the entrance of a reservoir as in the Glasgow water works when the quantity of water discharged may be known by measuring the depth of water flowing over the weir, or the record may be taken by using a float; but in that case the quantity is the average and not the actual consumption at any moment. To know the latter the most suitable place when the gauge is to be erected would be the outlet of a reservoir; but here again an overflow weir can not be used since the water level in a reservoir varies from time to time, and a recourse must be taken to a submerged orifice as in the outlet of the settling tank of the Yokohama water works where John Henry T. Turner, B. Sc. had devised an ingeneous apparatus to record the difference of levels of the upper and lower surfase of the orifice (vide "Proceedings of Institution of Civil Engineers" vol, C) After using a submerged orifice 2 feet wide and 6 inches high, he says: "The arrangement of pulleys by which the recording pencil is actuated solely by the relative waterlevels on the two sides of the orifice, without reference to the actual waterlevels, is shewn in the annexed figure. The diameters of the double pulley A, which turns on a fixed axle are 4 to 1; there of the double pulley, B, which turns on an axle suspended from A, are 3 to 1; C and D are fixet guiding pulleys; W is a weight hung on the end of the continuous cord from the upper float round C and A. The discharge through the orifice under the actual conditions of working was ascertained by experiment, and found to



be very accurately expressed by the formula.

$$Q = 2000\sqrt{h}$$

where Q denotes gallons discharged per minute, and h the head of water in feet."

Thus the curve traced out by the pencil shews the *rate of flow*, and it is very tedious to know the total quantity discharged for any length of time; since the curve can not directly be integrated.

In the Nagasaki waterworks, common inferential water meter was used for the 14 inch discharge main from the clear water tank. Here to total quantity only can be read but not the rate of discharge at any moment. Moreover, there is no recording arrangement, and the water becomes cumbrous and costly as the diameter of the main becomes larger even it is divided into a number of smaller diameters : in the case of Nagasaki three 12 inch meters were used for the 14 inch main.

The writer had seen last year in the Glenfield Company of Kilmarnock near Glasgow that Mr. Hutchison was applying for patent of a water discharge recorder for weirs which records both the *rate* and *total amount* of the discharge by means of the cam whose angular distances represent the head of water and the radii the corresponding discharge. Now the machine is fully described in "Engineering" of Oct. 25 1895, and the writer is very glad to see that they were successful in bringing the machine into the market; but from the description it seems as if the machine is intended for the overflow weir and not for the submerged orifice. Perhaps the combination arrangement of Mr. Turner's differential pulleys and Mr. Hutchison's discharge recorder might have been applied for the latter case.

In our water works it is intended to record the discharge at the outlet of the service reservoir whose water level varies by 12 feet, this being the working depth of the reservoir.

A gauge basin was constructed with a partition wall in the middle in which a sharp edged submerged orifice can be fitted. The maximum discharge that is to be gauged was fixed at 36 cubic feet per second and this with the head of 3 feet.

Now in the forumla $v = c\sqrt{2gh}$ .... (1)

where v = velocity in feet per second,

c = constant for the orifice,

g = gravity acceleration 32.2 ft per sec. per sec.,

h = head of water in feet,

taking c = 0.62 for a circular sharp edged submerged orifice, we have the diameter of the orifice to be 2.305 feet.

The apparatus is shewn by figures 1 and 2, with two floats one in the upper and the other in the lower side of the orifice. They are hung over two pulleys AA′ each 12 inches in diameter, and resting in line on the set of friction pulleys BB of 6 inches diameter. By this arrangement the relative angular position of the pulleys A and A′ is wholely dependent on the difference of levels on the two sides of the orifice notwithstanding how much the actual water level in the reservoir may vary.

To the same axle as A is attatched the hollow cylinder C 4 inches in diameter and 7 inches long on the surface of which same two curves are out diametically opposite. This curve represents the equation (1), i, e. a parabola with the difference of levels as its absissa and the corresponding velocity and hence the discharge as its ordinate. The developed surface of the cylinder C is shewn in the fig. 3. To the axle of A′ is attatched the outer fork DD with grooved guides EE at the opposite ends, into which work the inner fork FF. The inner fork has, on the one side, two pins GG fitted to, and being guided by, the two curves on the cylinder C. and on the other side, the rod HK $\frac{1}{4}$ inch in diameter which goes into the center of, and is guided by the axle of the pulley A.

To the rod HK is fastened the circular catch L, giving its to-and-fro motion to the ink holder P which is pressed down to the cylinder M revolving nearly once in twenty four hours from the clockwork N.

The diagram sheet as in fig. 4 is wound to the cylinder M and the every day record of the discharge is thus obtained in which the height of the diagram represents at once so many cubic feet per second flowing, and the area enclosed between the diagram and the zero line represents the total amount of flow during the time under consideration.

It may be added that the apparatus was made at the cost of Yen 262,50 by messrs Takahashi & Co, clock and mashine makers of Temmabashi St, Osaka.

T. Sano.

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○歐洲ノ電車鐵道　昨年九月ノ調査ニ依レバ歐洲ニ於テ運轉シツヽアル電車鐵道ノ統計ハ左ノ如シ(蓄電池式ヲ除ク)

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